papers, which have been commenced, and are now in progress of printing; with the amount of liability of the Academy for what has not yet been paid.

4th. A statement of the terms of any agreement or contract entered into by the Council, with the author or authors of any such paper or essay, and the sum or sums of money advanced on that account.

5th. An account of all medals and rewards adjudged by the Council, and paid to any author for papers and essays, during the said period, from the 17th of March, 1828, to the 17th of March, 1844, with the dates of such payments and delivery.

6th. An account of the debts and liabilities of the Academy at this time, and also of their available assets.

It was moved by Dr. Apjohn,—That the Secretary of Council be requested to provide the Academy, at the next meeting, with the information required in Sir William Betham's notice.

The motion, after discussion, was withdrawn.

The Rev. H. Lloyd laid upon the table of the Academy a magnetical instrument, which had been recently constructed under his direction by Mr. Jones of London, and which he proposed to denominate the "Theodolite Magnetometer."

Much attention had of late been given to the construction of small magnetical instruments, for the use of travelling observers, and many improvements in their form had been effected by Prof. Weber, Mr. Fox, and Lieut. Riddell. Prof. Lamont had also recently adopted magnets of a very small size in all the instruments employed by him in his magnetical observatory, and had stated his conviction of their superiority over the larger magnets hitherto in use. Without entering at present into the grounds of this conviction, in the unlimited form in which it had been asserted

by Prof. Lamont, Mr. Lloyd said that, as respects certain instruments intended for observations of a particular kind, there seemed now to be a pretty general agreement on the subject. He had himself proposed an instrument for the determination of the changes of the Magnetic Inclination, in which the magnet was necessarily a small one; and the advantages of small magnets, in the delicate observation of the absolute Horizontal Intensity, seemed now to be fully recognized.

While engaged in considering the best form of an instrument intended for observations of the latter class, Mr. Lloyd was led to perceive, that the same apparatus might be made to serve also in the determination of the *Absolute Declination;** and, by a few slight additions in the details of its construction, in that of the *variations of the three magnetic elements*. It may likewise be employed for all the usual purposes of a *Theodolite;* and thus, with the addition of an ordinary Inclinometer, a Chronometer, and a Sextant, constitute a complete magnetical equipment for the use of the travelling observer.

The following is a brief description of the instrument.

A divided circle, similar to that of a Theodolite, is supported on a tripod base, with levelling screws. This circle is nine inches† in diameter; it is divided to 10′, and subdivided by two verniers to 10″. The upper plate of the circle has two‡ projecting arms, each carrying a pair of adjustable Y supports for the reading telescope, at a distance of six inches from the centre. The telescope rests in these supports on a tran-

* It may be proper to observe that this arrangement had occurred to the writer before he had seen Prof. Lamont's account of his magnetical Theodolite, an instrument in which the same end is obtained, although by different means.

† A circle six inches in diameter, and read to 20″, is sufficient for all the purposes of a travelling observer.

‡ *One* is sufficient, and the instrument will be so modified in all future constructions on the same plan.

sit axis, which is rendered horizontal by the help of a riding level. The aperture of the object glass is eight-tenths of an inch; a glass scale, divided to the $\frac{1}{400}$th of an inch, is fixed in its focus; and the eye tube is made to move across the scale in a dovetail slide.

The magnets are hollow cylinders, each furnished as a collimator with an achromatic lens, and a fine line cut on glass in its focus. There are four such magnets: two of them being $3\frac{2}{3}$ inches long, and half an inch in exterior diameter, and two 3 inches long, and three-eighths of an inch in exterior diameter. The larger magnets are furnished with a Y stirrup, in which they may be inverted; the smaller magnets have the ordinary tubular stirrup, with a suspension pin and screw socket. A hollow brass cylinder, of the same dimensions as the larger magnets, and carrying a small hollow cylindrical magnet within, serves to determine the amount of torsion of the suspension thread; it is likewise fitted up as a collimator.

There are two boxes, within which the magnets are to be suspended. That belonging to the smaller magnets is a rectangular box of copper, closed by mahogany sliding sides, and having a circular aperture at each end filled with parallel glass. It is $3\frac{1}{2}$ inches long, $1\frac{1}{2}$ inches wide, and 1 inch deep, internally; and the thickness of the metal is a quarter of an inch, so that it may act powerfully as a damper. A suspension tube of glass, eight inches long, is screwed into an aperture in the top of the box; and is furnished with a graduated torsion cap at top, and a sliding suspension pin. This box is made to fit on the centre of the upper plate of the circle, and is capable of removal at pleasure. The box employed with the larger magnets is of wood, and of the same form as the copper box, but somewhat larger. It is detached from the instrument, but may rest on the same stand. A small wooden piece with a mirror serves to illuminate the magnet collimator, either from above or from the

side, according as the light of day, or that of a lamp or candle, is employed.

The measuring rod employed in deflection experiments is a compound bar of gun metal, formed of two bars, the lower of which has its surface horizontal, and the upper vertical. It is three feet in length,* and is graduated on its vertical surface. It is placed upon the upper plate of the circle, beneath the box, and at right angles to its longer sides; and it is so fixed that it may be removed with ease, and replaced exactly in the same position. The support of the deflecting magnet slides upon the upper bar, and is furnished with a vernier, by means of which the distance of the two magnets may be determined with accuracy and ease.

The apparatus is furnished with two soft-iron hollow cylinders, nine inches long, and three-fourths of an inch in diameter, which fit in vertical sockets attached to the upper plate of the circle. By this addition the instrument is converted into an Induction Inclinometer, for the measurement of the changes of the Inclination. By a slight addition to the suspension apparatus, the instrument may likewise be used as a Bifilar Magnetometer, for the measurement of the changes of the Horizontal Force. These adaptations are, however, of minor importance to the travelling observer, whose main concern is with the absolute determinations; and in a fixed observatory it is essential that there should be separate instruments for the separate purposes.

The most convenient *order* of the observations to be made with this apparatus, when employed by the travelling observer, is the following.

1. Measurement of Absolute Declination.

The copper box and measuring rod being removed, one

* For the purposes of the travelling observer, it will be more convenient that this rod should be in two pieces. Two *single* bars, placed edgewise, will suffice.

of the larger magnets is to be suspended within the wooden box, which should be placed on the same stand with the divided circle, at a distance not less than one foot from its centre. The optical axis of the telescope, and that of the magnet-collimator, are then to be brought nearly into the same right line, by an azimuth movement of the top of the stand, and by a small parallel movement of the box. The torsion of the suspension thread is then to be determined by the help of the brass cylinder, and to be removed by means of the torsion cap. The magnet being then replaced, the coinciding division of the scale is noted, with the magnet direct and inverted, and the mean of the two readings is the division corresponding to the magnetic axis. The verniers of the circle being then read, the telescope is to be turned until the division so found coincides with a fixed mark, whose azimuth is to be determined at leisure. The latter determination is made by the help of the same Theodolite, used in combination with the Chronometer or Sextant.

2. Observation of Vibration.

The upper plate of the circle is to be moved to its original position, and clamped there.

The coefficient of torsion of the suspension thread being determined, by the help of the torsion cap and glass scale, the magnet is to be set in vibration, and the time of 200 vibrations determined in the ordinary manner. The arc of vibration should be noted, by the help of the glass scale, at the commencement and end of the observation, and the temperature recorded at the same times.

3. Observation of Deflection.

The wooden box being removed, the metal box and the measuring rod are to be attached to the upper plate of the instrument. One of the smaller magnets is then to be suspended; and the larger magnet being transferred to its support upon the measuring rod, at a fixed distance, the upper plate and telescope are to be turned until the collimator line

of the suspended magnet is seen to coincide with the central division of the scale of the telescope. The verniers of the circle being then read, the deflecting magnet is reversed, and the telescope is moved until there is a new coincidence. The verniers being again read, the difference of the two readings is double the angle of deflection sought. It is necessary to eliminate the changes of the Magnetic Declination, which may occur between these two readings; and for this purpose the wooden box and one of the spare magnets may be employed by a second observer. But the same elimination may be made as effectually by a single observer, by taking a series of readings with the deflecting magnet alternately in the two positions. Finally, the observation is to be repeated with the deflecting magnet at the same distance on the other side of the suspended magnet, and the mean of the two results taken as the deflection corresponding to that distance.

The quantity sought may be inferred from the angle of deflection at a *single* distance, with as much accuracy as is generally attainable in observations made in the open air, or in a tent; and, in such cases, it will generally be found more advantageous to multiply the observations at the *same* distance, in the manner already mentioned, than to repeat them at *two* or *more* distances. The distance should be about *five times* the length of the magnets.

The preceding arrangement is suggested chiefly in regard to the economy of time. But, when the observer has sufficient leisure, it is desirable that the time of observation of the two elements should be as near as possible to the epochs of their principal maxima or minima, the periodical variation being then least. For this purpose the observations should be so arranged, that the middle of the observation of Intensity may fall between 10 and $10\frac{1}{2}$ A. M.; and that of the observation of Declination between 1 and $1\frac{1}{2}$ P. M. In this case, then, the preceding arrangement should be nearly reversed. The observer should commence with the observation of de-

flection; proceed at once to the observation of vibration, determining the coefficient of torsion at the end; and, lastly, make the preliminary arrangements (of detorsion, &c.), for the determination of the Declination, deferring the observation itself until 1 P. M. If there be a second observer, he should undertake the observation of Inclination, and such sextant observations as may be required for the determination of the Latitude, the Time, or the true Meridian. The observation of Inclination should be simultaneous with that of the Horizontal Intensity; the astronomical observations may be made whenever most convenient.

The Theodolite Magnetometer may likewise be employed with advantage in a fixed observatory, especially in observations of the absolute Intensity; and it is worthy of remark, that if the *differential* instruments used in connexion with it be small ones, the circle of this instrument may be employed in their adjustments, and their construction thus reduced to the simplest possible form.

Mr. Wm. R. Wilde read a notice of the opening of some Tumuli, by Mr. Nugent, and the Rev. Dr. Todd (V. P.) on the part of Mr. Nugent, presented a stone of a peculiar form, found in one of the Tumuli described.

The thanks of the Academy were given to Mr. Nugent, for his communication and donation.

Mr. R. Mallet presented the results of his analysis of a porcelain clay, discovered some years ago by him, at Howth, and since extensively brought into use for the manufacture of crucibles.

The clay is found upon the southern side of the peninsula of Howth, which consists principally of quartz rock; it exists in large concretionary masses, or highly irregular beds, and appears to have reached its present position by